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NANTICOKE WATER MOVEMENTS

1977

June 1979

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NANTICOKE WATER MOVEMENTS, 1977

Balbir Kohli

Water Resources Branch

Ontario Ministry of the Environment

135 St. Clair Ave. W.

Toronto, Ontario

M4V 1P5

June 1979

NANTICOKE WATER MOVEMENTS 1977

SUMMARY

The continuing interdisciplinary investigations by the Nanticoke Environmental Committee included a water movement study offshore of Nanticoke, Lake Erie during 1977. Two current instruments were operated in Lake Erie, offshore of the Ontario Hydro Generating Station, from July to November 1977. The resultant currents varied from 1.6 to 3.2 cm.s^{-1} with persistence factors of 0.31 to 0.58. The direction of the net monthly currents appeared to progress clockwise from moving toward the north in September to moving toward the east-northeast in November. However, the resultant currents were predominantly from the west for 60% of the time and parallel to the east-west axis for 80% of the record.

Spectral analysis showed the presence of some lakewide oscillations in an east-west direction. The effects of seiches and the shoreline on the local currents is suggested also by the spectral periods of the 1977 water movement data.

NANTICOKE WATER MOVEMENTS 1977

INTRODUCTION

The continuing interdisciplinary (biological, chemical and physical) investigations by the Nanticoke Environmental Committee (NEC) included a study of the water movements offshore of Nanticoke, Lake Erie during 1977. Two submersible self-recording current instruments were operated offshore of Ontario Hydro Generating Station (see Fig. 1 for instrument operation sites). The recording intervals of the meters were set during the instrument calibration prior to installation. A Geodyne current meter with a 20-min. recording interval operated from July 22 to August 31, 1977, at location 025. A Plessey MO21 instrument with a 10 min. recording interval operated from September 20 to November 14, 1977, at location 179.

The physical processes during 1977 were examined and compared to the previous investigations (NEC, 1973 and 1978; Kohli, 197⁴, 1976, 1977, 1978) to determine any trends or changes in the processes. The data collected were numerically smoothed and divided into monthly records (see Appendix 1) to facilitate comparison with the previous investigations. Two-dimensional frequency tables for current speed and direction as well as a one-dimensional frequency table for water temperature were produced by statistical analysis of each data set. The physical processes responsible for coastal water movements were identified by spectral analysis of each data set.

DISCUSSION

Water Movements

The resultant currents (vector averages) are represented in Figure 1, indicating that the net water movements for the western station (025) were primarily to the northwest towards shore during the last 10 days of July 1977 and to the east during August 1977. The net water movements at the eastern site (179) were toward the shore progressing from flow towards the north-northeast in September to towards east-northeast in November. Table 1 presents the summary of statistical results of the currents at both locations. The resultant currents ranged from 1.6 to 3.2 cm.s⁻¹, while the arithmetic average current speed varied from 3.5 to 6.9 cm.s⁻¹. The maximum current speed recorded during the 1977 study period was 75 cm.s⁻¹ at location 179 in October. The persistence factors ranged from 0.31 to 0.58 (see Table 1). The mean speed of all arithmetic average currents during 1977 was 5.5 cm.s⁻¹, with a standard deviation of 1.4 cm.s⁻¹. With the exception of September 1977, the current magnitudes were maintained during the study and the arithmetic averages remained within one standard deviation from the mean (from 4.1 to 6.9 cm.s⁻¹). During September 1977, the arithmetic average speed was 3.5 cm.s⁻¹. Thus, the currents were temporally homogeneous during the study period.

Studies were conducted at location 025 during July 1973 and at station 173 (close to the present site 179 -see Fig. 2) during September to November 1975.

The results of those studies (Kohli, 1974 and 1977) indicate that the resultant currents varied from 1.3 to 4.1 cm.s^{-1} , the arithmetic average current speed ranged from 3.5 to 4.8 cm.s^{-1} and the maximum current speed recorded was 24 cm.s^{-1} . The resultant currents, at mooring 025, moved toward the southwest direction during July 1973. At site 173, they were directed toward the shore in the northeast quadrant during May to November, 1975. The results of the 1973 and 1975 studies compare well with those of 1977 except the direction of net currents at location 025 shifted 90° clockwise in July 1977 from its July 1973 position.

In 1974, current instruments were operated at stations 027 and 028, in the vicinity of the 1977 moorings. The resultant currents during 1974 varied from 0.9 to 5.8 cm.s^{-1} , the arithmetic average current speed ranged from 2.5 to 7.0 cm.s^{-1} , while the maximum speed of 38 cm.s^{-1} was recorded (Kohli, 1976). The direction of currents during 1974 remained predominantly towards the east.

Currents in the vicinity of Hydro G. S. discharge channel (location 025) appear to be generally similar, in magnitude in 1977 as they were during the earlier years 1973 to 1975.

The resultant direction of the currents remained towards the east. Thus there has been no significant differences in currents from year to year inspite of the gradual increase of production at the Hydro plant and the cooling water discharge. During 1977, the Hydro plant reached production of approximately 30% of its designed capacity (4200 MW). As the production increases, larger flow rates and temperature rise will result and these increased factors may alter the current pattern and or magnitude in the vicinity of the discharge.

For all instrument locations, during 1968-77, the comparative water movement characteristics are presented in Table 2 (see Fig. 2 for the instrument locations during 1968-76). During four out of five monthly data sets of the 1977 study, the currents were parallel to the resultant direction for more than 30% of the time. For the entire study period 1968-77, in six-sevenths of the data sets, the currents remained parallel to the resultant in excess of 30% of the time. Distances travelled along the resultant direction in 10 hours (arbitrarily chosen) were computed to facilitate comparison of water movements. The results are presented in Table 2. During 1977, the average distance travelled in the 10 h, was 2.4 km with a standard deviation of 0.82 km (average/standard deviation = 3.0) and was within the range found in the previous studies (see Table 2). The percentage time distribution of net currents in the major directions are presented in Table 3 and Figure 3.

During 1977, the net currents were from the west for 60% of the time. For the entire study period of 1968-77, the net water movements were from the south for 7%, the west for 57%, the north for 13% and the east for 23% of the time. Consequently the currents were parallel to the shore line i.e. along the east-west direction for 80% of the time (1968-77).

Table 4 and Figure 5 present the mean monthly wind speed at Simcoe, Ontario. Analysis of variance ($F_{7,88} = 2.08 < F_{0.99}(7,88) = 3.28$) shows that there were no significant differences of the mean monthly wind speeds, between the years 1968-77. Consequently, the variations of the wind speed may not have any significant effect on the variations of the current speed over the years 1968-77.

Water Temperatures

Table 5 presents the one-dimensional frequency of occurrence of water temperature at two sites (025 and 179) for July to November 1977. The monthly mean water temperature at location 025 (2.4 m from bottom in 6.1 m of water) was 19.7°C and 21.5°C during the last 10 days of July and August 1977. At the mid depth of location 179 in 8.5 m of water, monthly water temperatures average 18.1°C , 12.2°C and 10.9°C during September, October and November respectively. The monthly standard deviations range from 0.8 to 1.9°C (see Table 5).

Auto Spectra

A summary of the major spectral periods of currents (along the east-west and north-south directions) is presented in Table 6. No significant spectral periods were observed in the north-south or east-west directions at station 025 in July. The significant spectral periods in August were 10 h in the north-south direction and 4.4 h and 2.3 h in the east-west direction at station 025. The 4.4 h period in August compares well with the fourth mode (4.1 h) of the longitudinal oscillations computed for Lake Erie by Rockwell (1966).

The only major period for station 179 in September was 5.2 h in the north-south direction while no significant periods were observed in the east-west direction. During October, location 179 exhibited 7.5, 3.0 and 2.5 h (along N-S) and 3.5 h (along E-W) as significant periods. The 3.5 h period compares well with the first oscillation mode of Lake Erie, i.e. 3.69 h (Rockwell, 1966). The 5.7 h period was observed along the E-W direction at site 179 during November and this is the third mode of oscillation of Lake Erie. Comparison of Table 6 with the results of Rockwell (1966) shows the presence of the first, third, fourth and fifth modes of oscillation along the E-W direction (parallel to the lake shoreline). Therefore, the currents may be influenced by the lakewide motions in the E-W direction. The 7.5 and 10.0 h periods along the N-S direction may be due to lakewide seiches.

Table 7 presents the comparison of significant periodicities of the lake currents since the study commenced in 1968. Generally, lower periodicities associated with the lakeshore geometry, local effects and the theoretical oscillation modes of Lake Erie were predominant in the 1977 results except for one 10 h period. During the previous years (1968-76), while lower significant periods were present, some periods greater than 10 h were observed more commonly. The smallest periods of the years from 1973 to 1977 may be caused by the close proximity of the instrument locations to the shoreline and/or development effects.

CONCLUSIONS

During 1977, current magnitudes offshore of the Ontario Hydro Generating Station at Nanticoke on Lake Erie were generally similar to most of the earlier studies in the area. The resultant speed varied from 1.6 to 3.2 cm.s^{-1} while the arithmetic mean speed ranged from 3.5 to 6.9 cm.s^{-1} . The net current directions appeared to progress clockwise from moving towards the north in September to moving towards the east-northeast, in November. The currents were predominantly from the west for 60% of the time and along the east-west axis (parallel to the shoreline) for 80% of the time as water movements are generally parallel to the shore in the coastal region.

The presence of theoretical oscillation modes in the observed spectral analysis shows some lakewide effects on the local currents. The influence of local shore geometry are also suggested by the spectral periods of the 1977 current data.

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TABLE 1: Statistical Summary of Current Meter Operations, Offshore of Nanticoke, Lake Erie, 1977.

	LOCATION				
	025		179		
	PERIOD				
	Jul	Aug	Sep	Oct	Nov
Resultant direction coming from 0° as North	125	267	208	231	246
Resultant Speed (cm.s^{-1})	2.19	3.15	2.03	2.64	1.59
Average Speed (cm.s^{-1})	6.92	6.92	3.53	5.18	5.08
Maximum Speed (cm.s^{-1})	16.72	21.41	35.63	74.56	23.36
Persistence Factor	0.32	0.46	0.58	0.51	0.31
Percentage of Negligible* Speed (% of recording period)			7	9	7
Percentage of time going in direction of resultant	20	30	30	38	19
Total number of readings	720	2232	1584	4464	1947
Interval of readings (mins.)	20	20	10	10	10

* $< 0.30 \text{ cm.s}^{-1}$

TABLE 2

COMPARISON OF WATER MOVEMENT RESULTS WITH PREVIOUS STUDIES, NANTICOKE REGION, LAKE ERIE

Loca- tion Code	Period	Resultant Direction Coming from 0° as North	Percentage of Time Going			Percentage of Negligible (<0.3 cm.s⁻¹) Currents	Max. Percentage Occurrence in any Speed Class Range (except negligible)	Mean of Speed Class Range with Max. Occurrence (cm.s⁻¹)	Mean Speed in direc- tion of Resultant (cm.s⁻¹)	Distance Travelled Along Resultant (in 10 h) (km)	Mean of Distance Travelled (in 10 h) (km)	Standard Deviation of Distance Travelled (km)
			In direc- tion of Resultant	Opposite to Resultant	Along the Resultant Axis							
022	Aug 68	262	40	14	54	15	27	4.5	6.2	2.2		
022	Sep 68	277	45	23	68	10	33	4.5	5.1	1.8		
023	Sep 68	277	52	11	63	54	25	1.7	2.7	1.0		
021	Oct 68	272	44	26	70	18	25	4.5	7.2	2.6		
022	Oct 68	271	59	17	76	10	20	4.5	9.8	3.5	2.62	1.29
023	Oct 68	268	52	11	63	31	22	1.7	6.2	2.2		
021	Nov 68	298	36	26	62	28	27	4.5	3.7	1.3		
022	Nov 68	273	85	0	85	1	23	4.5	13.2	4.7		
023	Nov 68	273	59	22	81	21	20	4.5	12.0	4.3		
021	May 69	256	43	13	56	36	21	1.7	6.2	2.2		
024	May 69	278	50	16	66	31	16	7.5	9.0	3.2		
021	Jun 69	74	33	28	61	38	25	1.7	3.1	1.1		
022	Jun 69	255	24	9	33	24	25	4.5	5.0	1.8	1.95	0.96
024	Jun 69	276	38	9	47	28	21	4.5	9.6	3.5		
021	Jul 69	67	22	15	37	29	29	1.7	3.5	1.3		
022	Jul 69	15	54	1	55	25	22	4.5	4.6	1.7		
024	Jul 69	18	12	7	19	35	22	1.7	2.2	0.8		
021	Jan 70	255	40	25	65	41	20	4.5	6.8	2.5	1.45	1.48
021	Feb 70	69	33	12	45	74	10	4.5	1.1	0.4		
025	Jul 73	16	16	7	23	19	23	1.7	3.5	1.3		
026	Jul 73	125	10	4	14	57	15	1.2	1.6	0.6		
026	Aug 73	77	28	11	39	74	15	1.2	0.7	0.3	0.79	0.42
026	Sep 73	107	25	12	37	48	15	3.0	2.7	1.0		
028	Apr 74	306	50	1	51	15	16	1.5	5.8	2.1		
028	May 74	300	30	9	39	4	15	4.0	6.8	2.4		
028	Jun 74	305	42	8	50	30	20	1.7	4.6	1.7		
028	Jul 74	287	18	13	31	3	17	3.0	15.4	5.5		
027	Aug 74	35	27	15	42	18	19	1.5	4.1	1.5	2.23	1.35
027	Sep 74	295	17	5	22	15	21	1.5	2.2	0.8		
027	Oct 74A	245	35	5	40	6	31	1.5	5.0	1.8		
027	Oct 74B	255	26	7	33	10	22	1.5	4.4	1.6		
028	Oct 74	301	49	2	51	2	21	3.0	9.7	3.5		
028	Nov 74	255	26	10	36	10	36	1.7	3.8	1.4		
171	May 75	204	17	6	23		49	11.0	13.0	4.7		
172	May 75	90	40	20	60		17	4.5	7.9	2.8		
173	May 75	229	24	12	36	11	19	1.7	8.4	3.0		
174	May 75	264	37	5	42	9	13	1.5	6.9	2.5		
171	Jun 75	157	8	7	15		23	12.5	13.8	5.0		
172	Jun 75	113	15	19	34		15	5.0	9.0	3.2		
173	Jun 75	224	36	7	43	1	12	5.0	14.2	5.1		
172	Jul 75	284	48	0	48		4	2.5	2.3	0.8		
174	Jul 75	276	52	3	55	6	13	3.5	4.6	1.7		
171	Sep 75	98	44	18	62		16	7.0	12.5	4.5		
172	Sep 75	98	58	15	73		17	5.0	14.2	5.1	3.49	1.54
173	Sep 75	271	41	5	46	7	24	3.0	5.2	1.9		
174	Sep 75	276	49	15	64	3	17	3.0	7.5	2.7		
171	Oct 75	100	31	23	54		15	7.0	16.0	5.8		
172	Oct 75	101	50	17	67		22	7.0	15.2	5.5		
173	Oct 75	260	29	9	38	11	14	1.5	6.4	2.3		
174	Oct 75	290	25	13	38	5	21	3.0	7.2	2.6		
171	Nov 75	323	46	2	48		18	2.5	5.2	1.9		
172	Nov 75	90	71	8	79		21	10.5	17.1	6.2		
173	Nov 75	270	44	4	48	6	26	1.2	7.5	2.7		
174	Nov 75	290	35	6	41	5	30	1.7	12.5	4.5		
175	May 76	261	40	0	40	14	22	1.5	3.0	1.1		
176	May 76	345	45	9	54	34	25	0.7	1.5	0.5		
175	Jun 76	139	35	5	40	16	24	9.0	4.5	1.6		
176	Jun 76	43	8	14	22	30	19	0.7	2.8	1.0		
175	Jul 76	283	18	8	26	6	23	9.0	4.0	1.4		
176	Jul 76	83	34	13	47	20	20	1.5	4.1	1.5	1.31	0.40
175	Aug 76	312	18	7	25	15	19	8.0	3.4	1.2		
176	Aug 76	69	24	12	36	28	20	1.5	3.4	1.2		
175	Sep 76	346	18	10	28	6	30	3.0	4.6	1.7		
175	Oct 76	40	20	10	30	6	32	9.5	5.4	1.9		
025	Jul 77	125	20	7	27	2	17	5.5	8.9	3.2		
025	Aug 77	267	30	5	35	8	28	6.0	6.9	2.5		
179	Sep 77	205	30	4	34	7	29	3.0	3.7	1.3	2.48	0.82
179	Oct 77	231	38	10	48	9	39	2.2	5.9	2.1		
179	Nov 77	246	20	18	38	7	27	1.7	9.2	3.3		

TABLE 3 NET WATER MOVEMENT DIRECTIONS COMING FROM

Year	Total No. of Water Movement Records	South		West		North		East	
		# of Times	% of Total						
1968	9			9	100				
1969	8			4	50	2	25	2	25
1970	2			1	50				50
1973	4					1	25	3	75
1974	10			9	90	1	10		
1975	22	3	14	11	50	1	4	7	32
1976	10	1	10	3	30	4	40	2	20
1977	5	1	20	3	60			1	20
1968-1977	70	5	7	40	57	9	13	16	23

TABLE 4: Mean Monthly Wind Speed at Simcoe, Ontario

(km. h⁻¹)

year month \	1968	1969	1970	1973	1974	1975	1976	1977
Jan	15.3	17.4	14.2	21.6	17.4	17.7	20.6	22.0
Feb	19.3	15.1	18.8	16.1	17.2	16.4	21.4	20.9
Mar	15.9	16.9	17.1	17.4	18.5	18.2	21.6	19.5
Apr	16.1	15.0	17.5	18.3	18.7	17.9	19.8	18.2
May	14.2	13.7	15.6	15.9	15.3	12.1	17.5	15.3
Jun	12.7	12.4	13.5	14.2	14.0	13.2	14.5	14.2
Jul	11.7	9.8	11.7	13.2	12.4	11.4	11.6	13.7
Aug	10.9	10.0	10.8	12.1	10.5	10.9	10.9	12.6
Sep	10.3	10.5	12.1	14.0	12.9	13.4	12.9	12.6
Oct	12.4	13.0	12.9	14.2	14.3	16.3	15.4	15.6
Nov	15.1	12.9	18.2	19.2	14.8	18.0	19.0	16.7
Dec	17.7	14.0	17.9	17.2	14.2	17.9	19.5	19.3

Between years, $F_{7,88} = 2.08 < F_{0.99}(7,88) = 3.28$

There is No Significant Difference of Mean Monthly Wind Speed Between Years

TABLE 5: Temperature Frequency, Offshore of Nanticoke, Lake Erie,
1977 (Percentage of Occurrence)

Temperature Range °C	LOCATION				
	025		179		
	Jul	Aug	Sep	Oct	Nov
8:00 - 8.99					4.06
9:00 - 9.99				1.76	9.69
10.00 - 10.99				30.12	20.94
11.00 - 11.99				27.68	61.56
12.00 - 12.99				19.54	3.44
13.00 - 13.99				0.95	0.31
14.00 - 14.99				6.24	
15.00 - 15.99				5.02	
16.00 - 16.99			13.74	8.28	
17.00 - 17.99	19.57		32.06	0.41	
18.00 - 18.99	5.96		35.50		
19.00 - 19.99	26.81	8.87	18.32		
20.00 - 20.99	33.62	23.47	0.38		
21.00 - 21.99	12.77	29.06			
22.00 - 22.99	1.28	36.56			
23.00 - 23.99		2.05			
Total	100.00	100.00	100.00	100.00	100.00
Monthly Mean °C	19.70	21.45	18.11	12.22	10.93
Monthly Std. Dev. °C	1.26	0.96	0.90	1.91	0.79
Monthly Min. °C	17.40	19.59	16.79	9.43	8.70
Monthly Max. °C	22.30	23.66	20.09	17.06	13.05
Series Length (h)	240	744	264	744	324

TABLE 6: Summary of Major Spectra of Currents Offshore of
Nanticoke, Lake Erie, 1977 (80 percent confidence level)

Location	Month 1977	(hours)	
		North-South	East-West
025	Jul Aug	None 10.0*	None 4.4, 2.3
179	Sep Oct Nov	5.2 7.5*, 3.0, 2.5* 3.0*	None 3.5* 5.7, 2.1

* 95% Confidence Level

TABLE 7: Comparison of Spectral Results with Previous Studies Offshore of Nanticoke, Lake Erie
 Number of Occurrences of Significant Spectral Periods of Water Movements.

Significant Spectral Periods (h)	1968		1969		1973		1974		1975		1976		1977	
	North	East												
24		2												
22		1												
20	1	1	1	1										
17				1									1	
16	1													
15		1							1	1				
14	1			1										
13		1									1	1	1	
12		1		1				1	1	1			1	
11		4		1			1	1		2	2			
10											1		1	1
9	1						1	1	2	3	2			
8		1											1	
7		2								4	2	3		1
6		3			1	1	1		1	2	2	3		1
5		2					3	1	8	5	2	1	1	
4					1	1	2	3	12	4	4	5		1
3					2	2	4	4	15	9	6	4	2	1
2					1	1	1	2	14	12	7	4	1	2
No. of Monthly Data Sets	9		8		4		10		22		10		5	

80°05'

80°00'

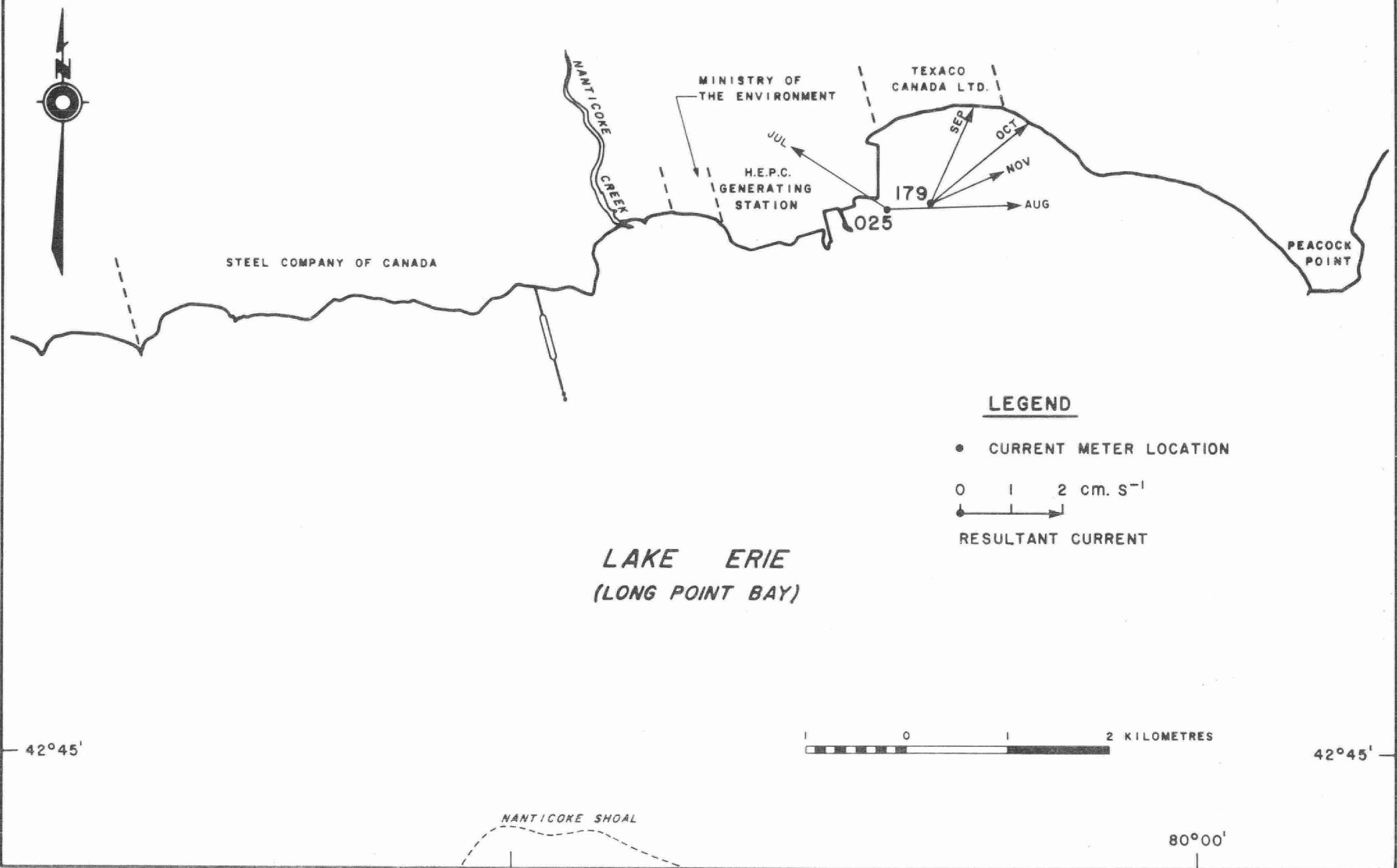


FIGURE 1 - RESULTANT CURRENTS OFFSHORE OF NANTICOKE, LAKE ERIE, 1977.

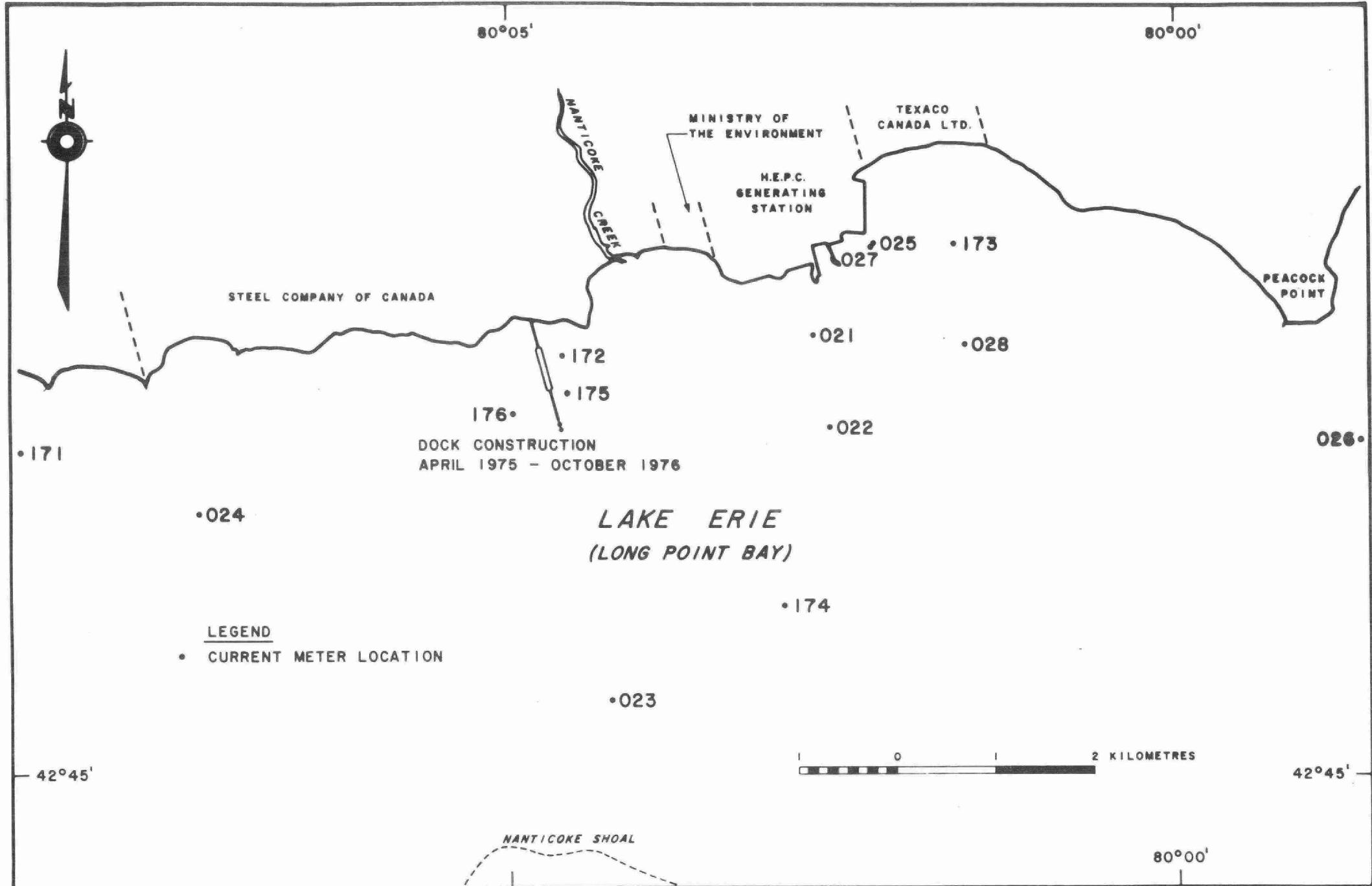


FIGURE 2 - STUDY LOCATIONS FOR PREVIOUS YEARS (1968-76) OFFSHORE OF NANTICOKE, LAKE ERIE

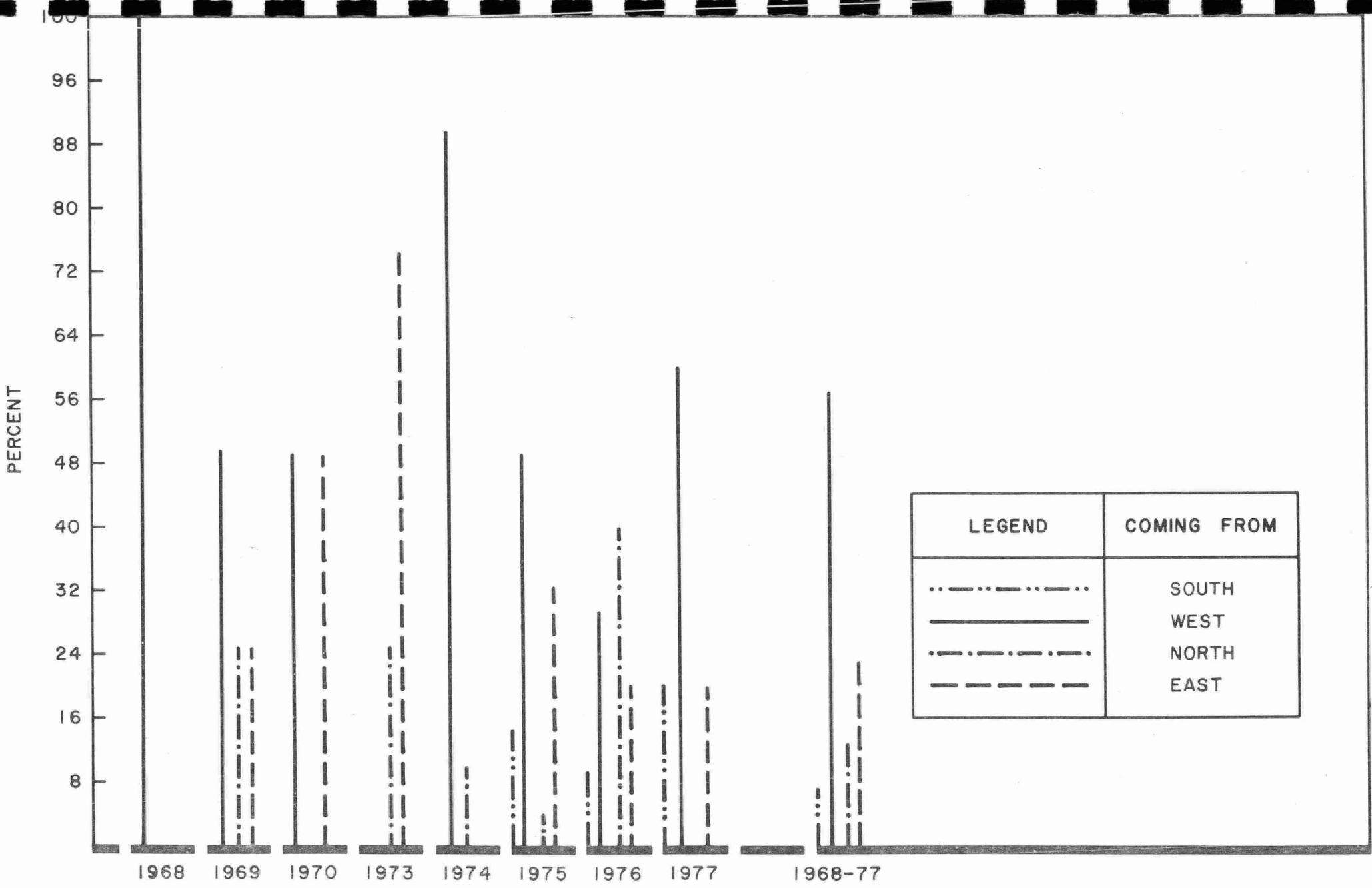


FIGURE 3 - NET WATER MOVEMENT DIRECTIONS (COMING FROM) OFFSHORE OF NANTICOKE, LAKE ERIE, 1968-77

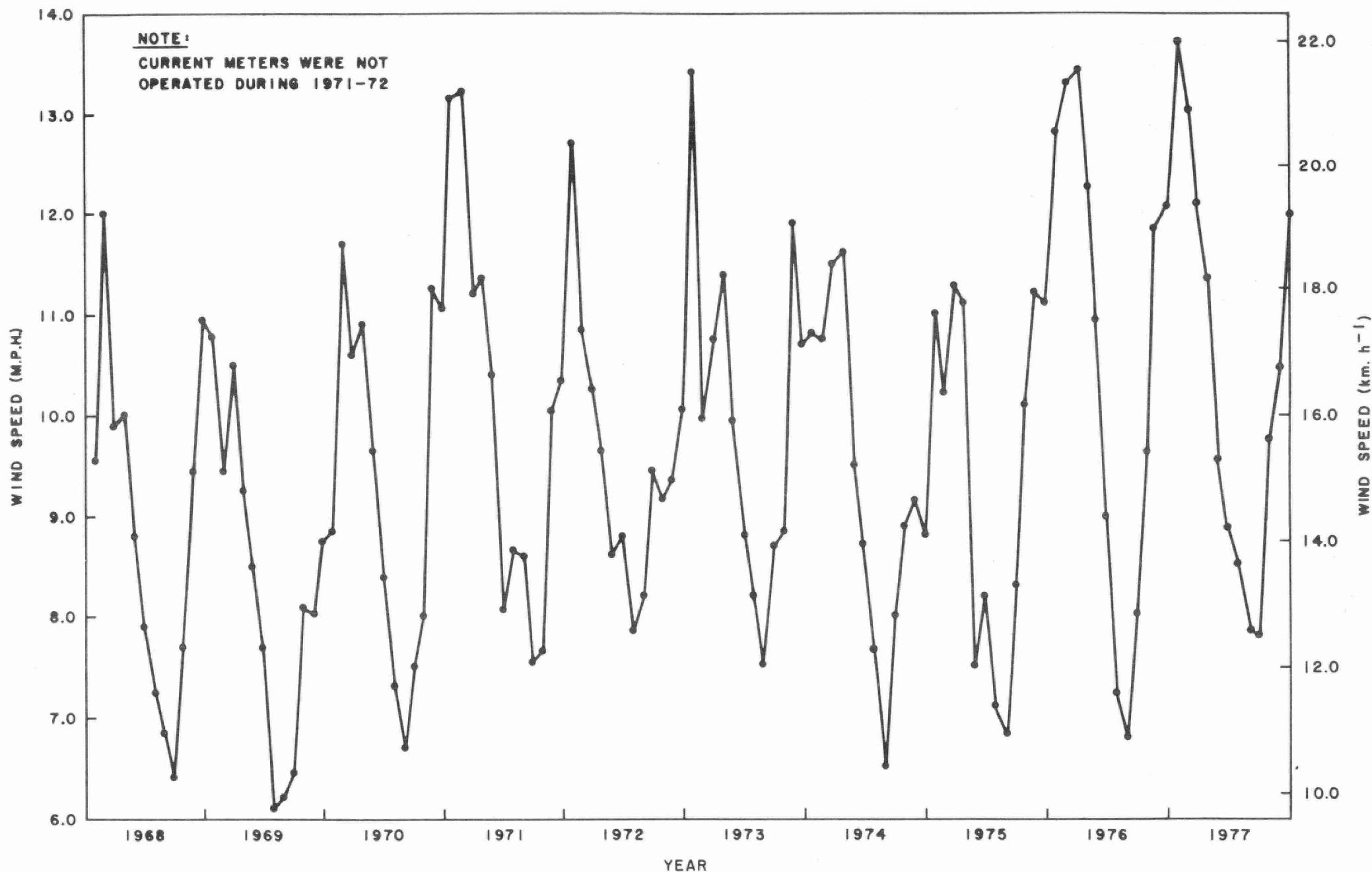


FIGURE 4 - WIND SPEED (MONTHLY MEAN) AT SIMCOE, ONTARIO.

APPENDIX 1

INSTRUMENTATION AND DATA ANALYSIS 1977

INSTRUMENT OPERATION

Two submersible, self-recording type instruments were operated during 1977, offshore of Ontario Hydro Generating Station, at Nanticoke in Lake Erie. A Geodyne 920 instrument was laboratory calibrated and set to record every 20 min. A Plessey M021 instrument was also laboratory calibrated and set to record every 10 min. The Geodyne instrument was operated at site 025 (see Figure 1) 2.4 m from bottom in 6.1 m of water from July 22 to August 31, 1977. The Plessey instrument was deployed at location 179 at mid-depth in 8.5 m of water from September 20 to November 14, 1977.

DATA ANALYSIS

All data were pre-whitened (numerically smoothed) after Blackman and Tukey (1959; p.29, 39, 74) using binomial coefficients after Panofsky and Brier (1968; p. 150). The pre-whitened data were then divided into monthly records to facilitate comparison with the previous data sets. Statistical analyses were performed on all data sets to produce the two-dimensional frequency of occurrence of the current speed and direction (see Tables 1.01 to 1.05).

The resultant currents ranged from 1.6 to 3.2 cm.s⁻¹ with the persistence factors of 0.31 to 0.58. The arithmetic average speed varied from 3.5 to 6.9 cm.s⁻¹ with the maximum recorded speed being 75 cm.s⁻¹.

One-dimensional frequency of occurrence of water temperature were computed for each record (see Table 4). The monthly mean water temperature varied from 10.9 to 21.5°C with standard deviations of 0.8 to 1.9°C during July to November.

The hourly average current speeds along north-south and east-west directions were computed. These two series were then subjected to the spectral analysis (Kohli, 1978) to compute the significant periodicities along the two major compass directions. Spectral analysis provides insight to the physical processes responsible for the currents.

REFERENCES

1. Blackman, R.B., and J.W. Tukey, 1959. The Measurement of Power Spectra. Dover Publications, Inc. New York, 198p.
2. Kohli, B. 1978. Physical Aspects of Toronto Harbour. 1972-75. Ontario Ministry of the Environment, 135 St. Clair Ave. West, Toronto, Ontario. 50p.
3. Panofsky, H.A., and G.W. Brier, 1968. Some Applications of Statistics to Meteorology. The Pennsylvania State University, University Park, Pennsylvania.

TABLE 1.01

LOCATION CODE : 0250
 AREA : NAUPTCOKE
 LAKE : ERTF

PERIOD : JUL 77
 LATITUDE : 42 47 54 N
 LONGITUDE : 80 02 26 W

FREQUENCY TABLE

DIRECTION (COMING FROM) IN DEGREES

SPEED(CM/S)	337.50	22.50	67.50	112.50	157.50	202.50	247.50	292.50	RDW SUMS
	22.49	67.49	112.49	157.49	202.49	247.49	292.49	337.49	
1.00 --	1.99	0.0	0.28	0.28	0.42	0.28	0.42	0.0	0.0
2.00 --	2.99	0.0	0.56	0.83	0.14	0.14	0.14	0.97	0.0
3.00 --	3.99	0.14	0.42	1.81	1.11	0.42	0.69	2.22	0.28
4.00 --	4.99	1.39	0.14	1.53	1.11	2.92	1.39	2.22	1.25
5.00 --	5.99	0.69	1.39	2.36	2.50	5.28	1.67	1.39	1.25
6.00 --	6.99	0.56	0.69	1.94	4.17	4.31	1.67	0.83	0.83
7.00 --	16.99	3.33	8.19	8.89	10.83	5.56	2.78	2.22	3.19
COLUMN SUMS	6.11	11.67	17.64	20.28	18.89	8.76	9.86	6.81	100.00

RESULTANT CURRENT IS

2.19 CM/S AT 125 DEG FROM NORTH

TOTAL NO. READINGS 720

MEAN CURRENT IS

6.92 CM/S

PERSTSTENCE IS 0.32

MAXIMUM CURRENT IS

16.72 CM/S

READINGS TAKEN EVERY 20^{MIN}

MINIMUM CURRENT IS

1.22 CM/S

METER OPERATIONS

METER OPERATED AT 2.4 M FROM BOTTOM IN 6.1 M OF WATER

STARTED AT 0.15 HRS. ON 22 TH DAY OF 7 TH MONTH 1977
 ENDED AT 23.55 HRS. ON 31 TH DAY OF 7 TH MONTH 1977

TABLE 14.03

LOCATION CODE : 1790
 AREA : NANTICOKE
 LAKE : ERTF

PERIOD : SEP 77
 LATITUDE : 42 47 56 N
 LONGITUDE : 80 01 57 W

FREQUENCY TABLE

DIRECTION (COMING FROM) IN DEGREES

SPEED (CM/S)	337.50-	22.50-	67.50-	112.50-	157.50-	202.50-	247.50-	292.50-	PW SUMS
	22.49	67.49	112.49	157.49	202.49	247.49	292.49	337.49	

0.0 --	0.30	0.63	1.33	1.01	0.32	1.52	0.51	0.95	0.44	6.69
0.31 --	1.99	0.63	2.97	4.48	4.29	4.67	10.10	1.52	0.63	24.29
2.00 --	3.99	0.13	0.32	0.44	2.84	8.59	13.38	3.54	0.44	29.57
4.00 --	5.99	0.32	1.01	1.20	0.69	4.29	8.71	1.70	0.32	18.24
6.00 --	7.99	0.25	0.44	0.69	0.13	2.78	4.10	0.57	0.0	8.96
8.00 --	9.99	0.0	0.57	1.20	0.13	0.32	1.26	0.88	0.0	4.36
10.00 --	35.99	0.0	0.06	1.07	0.13	0.38	0.38	0.76	0.0	2.78

COLUMN SUMS	1.96	6.69	10.10	8.52	22.54	38.45	9.91	1.83	100.60
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RESULTANT CURRENT IS	2.93 CM/S AT 205 DEG FROM NORTH	TOTAL NO. READINGS 1584
MEAN CURRENT IS	3.53 CM/S	PERSISTENCE IS 0.58
MAXIMUM CURRENT IS	35.63 CM/S	READINGS TAKEN EVERY 10 MIN
METERLESS CURRENT IS	0.0 CM/S	

METER OPERATIONS

METER OPERATED AT 4.3 M FROM BOTTOM IN 8.5 M OF WATER

STARTED AT 0.05 HRS. ON	20 TH DAY OF	9 TH MONTH 1977
ENDED AT 23.54 HRS. ON	30 TH DAY OF	9 TH MONTH 1977

TABLE 1.05

LOCATION CODE : 1790
 AREA : NANTICOKE
 LAKE : ERTE

PERIOD : NOV 77
 LATITUDE : 42 47 56 N
 LONGITUDE : 80 01 57 W

FREQUENCY TABLE

DIRECTION (COMING FROM) IN DEGREES

SPEED(CM/S)	337.50-	22.50-	67.50-	112.50-	157.50-	202.50-	247.50-	292.50-	PDA SUMS
	22.49	67.49	112.49	157.49	202.49	247.49	292.49	337.49	
0.0 --	0.30	0.51	1.59	1.54	0.77	1.18	0.92	0.15	0.26
0.31 --	1.99	0.87	4.21	5.50	5.50	5.39	3.75	0.72	26.61
2.00 --	3.99	0.31	3.44	6.47	2.26	1.59	5.44	0.82	21.26
4.00 --	5.99	0.10	0.98	3.39	0.0	1.03	2.98	1.39	0.51
6.00 --	7.99	0.10	1.13	3.39	0.0	0.56	2.41	1.85	0.31
8.00 --	9.99	0.0	0.98	2.88	0.0	0.10	1.34	3.08	0.21
10.00 --	23.99	0.0	0.05	1.75	0.0	0.0	2.57	11.56	0.56
CURRENT SUMS	1.90	12.38	24.91	8.53	9.86	19.41	19.57	3.44	100.00

RESULTANT CURRENT IS

1.69 CM/S AT 246 DEG FROM NORTH

TOTAL NO. READINGS 1947

MEAN CURRENT IS

5.08 CM/S

PERSISTENCE IS 0.31

MAXIMUM CURRENT IS

23.36 CM/S

READINGS TAKEN EVERY 10 MIN

MINIMUM CURRENT IS

0.0 CM/S

FFTER OPERATIONS

FFTER OPERATED AT 4.3 % FLOOR SECTION IN 8.5 M DEPTH

STARTED AT 0.03 FHS. ON

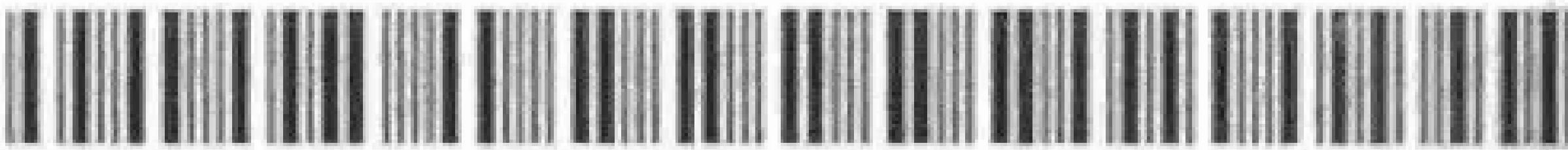
1 TH DAY OF

11 TH MONTH 1977

ENDED AT 12.22 FHS. ON

14 TH DAY OF

11 TH MONTH 1977



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